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The F.B.I. Research Conference

Whilst we were duly impressed by the setting of the Federation of British Industries' Conference on Industry and Research held last week at the Kingsway Hall, London, we were not quite satisfied as to the wisdom of staging such an affair at the present moment. It is true to state that in recent times there has been a plethora of papers read by eminent scientists at the Royal Society of Arts, in Newcastle, Manchester, and elsewhere, supplemented by erudite articles in *The Times* and the technical Press. By now, most of the industrial executives are familiar with practically all phases of research activities, and the bringing together of all the research *cognoscenti* on to one platform has added but little to the general reservoir of knowledge of the subject. Certainly some excellent examples of the results achieved were disclosed for the first time, yet, doubtless, these would have later been forthcoming in presidential addresses, and after-dinner speeches. Now we shall be treated to nothing but quotations for a few years. It may be that we are taking too narrow a view of the conference, but having for twenty-five years continuously, and unceasingly, advocated intense research, we found but little which has not been said before. There were obviously a few worthwhile suggestions made. For instance, a widely travelled businessman told the Conference that for industrial research to be a success it must never lose sight of the fact that to be successful it must aid the production of goods which people want, can afford to buy, and to have these available at the right time at the right place. Then Dr. Smithells made a strong plea for the clarification by the Government as to the priority situation as related to the building or extension of research laboratories. An expert on filtration made a favourable impression by stressing the impact work already accomplished might have on workshop conditions by instituting proper atmospheres to the benefit of both operatives and machinery.

The representatives of the foundry industry present were insistent that no time must be lost in correcting a statement made in one paper to the effect "that it is well known that a large proportion, probably as much as 80 per cent. of all ferrous and non-ferrous castings, are porous to liquids such as water, petrol or oil." We took it upon ourselves to make the necessary correction and designated the statement as "sheer poppycock," and demanded an apology to the foundry industry from the Author. The acclamation with which this correction was received gave the industry an ample assurance that its work—especially its wartime effort—was appreciated in research and industrial circles. It appears to us that if on every occasion, enthusiastic foundrymen will plainly state the achievements of their industry, they will do much to eradicate the effect of much ill-conceived anti-foundry propaganda now extant.

Sir William Larke quoted a Federation Survey which showed that no fewer than 9,000 graduate scientists were engaged in the research and development departments of British industries, with a total expenditure thereon of £20,000,000 annually.

Even though there were 1,400 delegates to this Conference, we are inclined to the belief that talks by such eminent people as Sir Edward Appleton, Sir Harold Hartley, or Sir William Larke to groups of metropolitan or provincial businessmen, or the technical institutes, has a more lasting benefit, as they are obviously knowledgable on every phase of research activities, whilst the atmosphere under such conditions is more intimate and the interests less diffuse.

MR. BORGERHOFF AND MR. REMY are to represent the Association Technique de Belgique at the forthcoming American Foundry Congress.

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FORTHCOMING EVENTS

(Secretaries are invited to send in notices of meetings, etc., for inclusion in this column.)

APRIL 5.

Institution of Mechanical Engineers:—"The Evolution of a Tank Transmission," by H. E. Merritt. At Storey's Gate, St. James's, Park, London, S.W.1.

Royal Statistical Society (Industrial Applications Section—London group):—"Statistics in Radio Valve Component Manufacture," by A. Gait. At the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, at 6.30 p.m.

APRIL 10.

Institute of Welding (West Scotland branch):—"Fabrication and Welding of Bridging Equipment," by R. G. Braithwaite. At 39, Elmbank Crescent, Glasgow, C.2, at 6.30 p.m.

Royal Society of Arts:—"Cast Iron in Contemporary Building and Engineering," by J. G. Pearce. At the Royal Society, John Adam Street, Adelphi, London, W.C.2, at 1.45 p.m.

APRIL 11.

Institute of Welding (N.E. Tyneside branch):—"Mild Steel Weld Metal from the Point of View of 'Snow Flakes,' Porosity, etc.," by H. F. Tremlett. At the Mining Institute, Neville Hall, Newcastle-upon-Tyne, at 6.15 p.m.

Staffordshire Iron and Steel Institute:—"Hardness and Hardenability of Steels," by H. A. MacColl. At the Dudley and Staffordshire Technical College, The Broadway, Dudley, at 7 p.m.

APRIL 12.

Institution of Chemical Engineers:—Annual corporate meeting. At the Connaught Rooms, Great Queen Street, London, W.C.2, at 11 a.m.

Institute of Welding (E. Scotland branch):—Annual general meeting; "Technical Efficiency in the Welding Shop from Design to Inspection of Finished Product," by F. Koenigsberger. At the Heriot Watt College, Chambers Street, Edinburgh, at 7.30 p.m.

Keighley Association of Engineers:—"The Development of British Jet Propulsion," by G. B. R. Feilden. At Devonshire Buildings, Devonshire Street, Keighley, at 7.30 p.m.

APRIL 24.

Institute of Welding:—"The Evolution of Welded Armoured Fighting Vehicles," by Major R. J. Fowler and Major L. F. Denaro. At the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, at 6 p.m.

Institute of British Foundrymen

APRIL 10.

Birmingham branch:—Annual general meeting. "Education in the Foundry Industry." At the James Watt Institute, Great Charles Street, Birmingham, at 7.30 p.m.

APRIL 13.

Lancashire branch:—Annual general meeting. At the Engineers' Club, Albert Square, Manchester, at 3 p.m.

APRIL 15.

Sheffield branch:—Annual general meeting. Short Paper competition. At the Royal Victoria Hotel, Sheffield, at 7 p.m.

APRIL 24.

London branch:—Annual general meeting. Short Paper competition. At the Charing Cross Hotel, at 7.30 p.m.

APRIL 27.

Newcastle branch:—Annual meeting. At the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6 p.m.

West Riding of Yorkshire branch:—Annual general meeting. At the Technical College, Bradford, at 6.30 p.m.

LONG-SERVICE CERTIFICATES and awards to 53 employees of the Darlaston works of Guest, Keen & Nettlefolds, Limited, were presented recently by Mr. M. Tollit, director and general manager.

A JOBBING FOUNDRY EXPEDIENT

BY "TRAMP"

Jobbing foundries are often called upon to produce at short notice a variety of castings for which no suitable boxes are available. One method of overcoming this difficulty is to bed the pattern in the floor and carry the top in a plain box.

For many jobs this is entirely suitable, but there are occasions when this method has its limitations, as on assembly there may be a "crush," if the box does not register exactly in the correct position first time.

Such a job is shown in Fig. 1, which is a bevel wheel of approximately 3 ft. 6 in. pitch circle diameter, where normally a joint would be taken off at A and

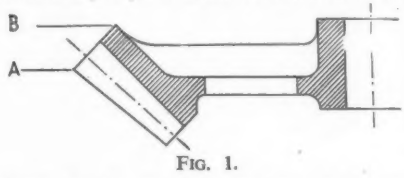

FIG. 1.

all above that line carried in the top. In the present instance, if this had been done it would have been very probable that, on closing, the sand forming the teeth would invariably be damaged by a "crush." It was therefore decided to adopt the expedient of making a number of false pieces to guard against this. The method being to mould as normal practice and make a joint off at A, dust with parting powder, and then make another joint off at B. Again dusting with parting powder, the top is placed in position, rammed, and lifted off. A sharp trowel is then used to cut the thickness of sand between A and B into a number of sections, which can be conveniently shifted back to allow of the pattern being extracted.

After withdrawal of the pattern, these pieces are again shifted into position, and the top placed on without the fear of a "crush," as all the projecting sand which could cause trouble is protected by the ring between A and B, and the job is converted into one with a plain joint, a simple expedient which saved considerable trouble.

NOTES FROM THE BRANCHES

LANCASHIRE.—Nearly a hundred members of the Lancashire branch of the Institute of British Foundrymen, accompanied by their president, Mr. Stanley Brooks, recently visited the works of the Staveley Coal & Iron Company, Limited, near Chesterfield. The party had a full day's programme and inspected the blast furnaces, coke-ovens, foundries and spun-pipe plants. The visitors were entertained to luncheon by the directors of the company and were warmly welcomed by Mr. H. H. Berresford, managing director. Mr. Brooks, on behalf of the visitors, thanked the Staveley Company for their hospitality and also for the facilities provided for the interesting and instructive tour of the plant.

EFFECT OF HEAT TREATMENT ON THE ENDURANCE LIMIT OF ALLOYED GREY CAST IRON*

By T. E. EAGAN

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[ABRIDGED]

As far as the Author can determine, Moore and Picco[1] are the only ones who have reported any results of the effect of heat treatment on an endurance limit. They ran endurance limits both in reverse bending and in torsion on specimens taken from a 7-in. I.D. cylinder with a 1¼-in. wall thickness, both in the "as-cast" and in the heat-treated condition on a grey cast iron of the following analysis: T.C., 3.07; Si, 1.26; Mn, 0.90; S, 0.08; and P, 0.15 per cent. The results they obtained are shown in Table I.

TABLE I.—*Endurance Limits for Irons Tested.*

Condition of Specimen.	Static Tensile Strength. Tons per sq. in.	Endurance Limits. Lbs. per sq. in.		Endurance Ratios.*	
		Bending.†	Torsion.†	Bending.	Torsion.
As cast	21.4	21,000	16,500	0.44	0.34
Heat treated‡	34.1	25,000	22,000	0.33	0.29

* Ratio of endurance limit to static tensile strength.
† Completely reversed cycles of stress for unnotched specimens.
‡ Preheated slowly to 537 deg. C., then heated to 870 deg. C., quenched in oil and reheated to 537 deg. C.

It will be seen that although they obtained a 58 per cent. increase in tensile strength, there is only a 19 per cent. increase in the endurance limit in reverse bending, and a 30 per cent. increase in torsion. The endurance ratio (endurance limit divided by tensile strength) is actually reduced both in bending and in torsion. In the development of materials which would serve for cast crankshafts, the possibilities of obtaining high endurance limits by heat treatment were investigated. This Paper covers this investigation.

Two crankshafts were cast of a processed cupola iron† of the following analysis: T.C., 2.84; Si, 1.40; Mn, 0.67; P, 0.11; S, 0.059; Ni, 1.69; Cr, 0.16; Mo, 0.46; and Cu, 0.15 per cent. (The chromium and the copper were not added but were residuals in the scrap. The nickel and molybdenum were added to the charge in the cupola and not to the ladle.)

One of these crankshafts was allowed to cool to room temperature in the mould. The other was shaken out of the mould when it reached 870 deg. C., and allowed to cool in still air to room temperature. The temperature at which the shaking out was done was determined by a thermocouple inserted in the mould cavity before pouring. The crankshafts cast were of such a design that a number of test sections 6½-in. O.D., by 3-in. I.D., by 9½ in. long, could be cut. The 3-in. I.D. was a cored hole, which gave a metal section of 1¼-in. thickness.

A sufficient number of test specimens was obtained from the crankshaft that cooled in the mould to carry on the various heat treatments given in the following. The shaking-out of the crankshaft at 870 deg. C., and allowing it to cool in air, is considered as one type of heat treatment, so the results are included. The standard practice in this foundry is to give a stress-relieving treatment at 565 deg. C. to all cast crankshafts. Both shafts, therefore, were given this treatment before the test specimens were cut from them. The "as-cast" condition used in this Paper means that the pieces were stress relieved.

The following heat treatments, with the exception of heat treatment *D*, were given to the test sections obtained from the crankshaft.

Heat Treatment A. Heat slowly to 870 deg. C., hold 2 hr. Quench in oil. Reheat to 565 deg. C.—2 hr. Cool in air.

Heat Treatment B. Heat slowly to 870 deg. C., hold 2 hr. Oil quench to 482 deg. C. Hold at 482 deg. C.—16 hr. Cool in air.

Heat Treatment C. Heat slowly to 870 deg. C., hold 2 hr. Oil quench to 338 deg. C. Hold at 338 deg. C.—16 hr. Cool in air.

Heat Treatment D. Cool in mould to 870 deg. C. Then strip from mould and air cool, then stress relieve at 565 deg. C.

Heat treatment *A* is the usual "harden and temper" treatment used to produce high tensile strength and high hardness. The tempering temperature of 565 deg. C. was given to approach the maximum hardness that could be machined. Flinn and Reese,[2] working with nickel molybdenum alloyed grey irons with T.C. of 2.50 per cent. and Si of 2.50 per cent., have shown that extremely high physical properties may be obtained if the matrix structure of the iron is acicular.

*Acknowledgment is given to the "American Foundryman."
†All of the material used for this investigation was manufactured under licence of The Meehanite Metal Corporation.

Effect of Heat Treatment

They have also shown that this acicular structure is an austenite transformation product which is formed at temperatures of from 482 to 260 deg. C., provided that the material is austenitic when it reaches this temperature range.

Some time must be spent in this temperature range to produce the desired structure. In other words, if the rate of cooling of the material is sufficiently fast to bring it past the nose of its isothermal transformation curve (S curve) and then held in the range of 260 to 482 deg. C., an acicular structure will be formed. Mould cooling is so slow that it is practically impossible to form an acicular structure in unalloyed grey iron. The addition of nickel and molybdenum shifts the nose of the curve to the right, giving a longer nose time. This allows the retention of the austenite down into the range of 260 to 482 deg. C., where, if the mould cooling rate is satisfactory, the acicular structure will be formed.

Flinn and Reese[2] also have pointed out that the combined carbon in the matrix must be eutectoid composition to form a truly acicular structure. This range of carbon is 0.70 to 0.90 per cent. In order to produce this eutectoid composition in any given section, a proper balance between the total carbon and silicon must be maintained.

Heat treatments *B*, *C* and *D* are attempts to produce the acicular structure in the section cast and with the analysis previously stated, which by microscopic examination was proved to be almost eutectoid in composition. Since the formation of the acicular structure is really a function of the cooling rate, it was believed that this cooling rate could be controlled by heat treatment, and thus the acicular structure could be produced. As no "S curves" were available for the composition of metal involved, oil quenching was considered to be sufficiently fast to cool past the nose of the curve. No method was available for determining the temperature at which to remove the test section from the oil and place it in the furnace for holding. This temperature had to be estimated, so it is very possible that it was above or below the holding temperatures of 482 deg. C. and 343 deg. C. used. All that is certain is that both test sections were below 537 deg. C. when taken out of the oil.

Holding Temperatures

The holding temperatures of 482 deg. C. and 343 deg. C. were arbitrarily chosen. Other temperatures would have been tried if there had been sufficient material to do so. The air-cooling treatment was one that had produced promising results on previous experiments, hence it also was tried.

Sufficient material was available in each test section to obtain tensile tests, impact test and endurance limit bars. Microstructure specimens were cut from the threaded end of the tensile test bars. Standard A.S.T.M. tensile bars of 0.800-in. dia. were cut from the test sections so that the centre of the test bar was at the centre of the section wall. The endurance limit bars and impact test bars were also located in the same position. Therefore, all testing was done on approximately the metal which was located at the same position in the section thickness of the test section.

All of the testing was done on a Baldwin Southwark endurance testing machine capable of handling the 1-in. diameter specimens and testing in reverse bending. The ends of the specimen have collars shrunk on to them, which are, in turn, bolted to the spindles of the machine. The speed of operation of the machine is 3,475 r.p.m.

The Izod impact used is one that has been recommended in England and employs an unnotched specimen of 0.798-in. diameter so held that it projects 1½ in. above the holding jaws. The standard 120 ft.-lb. Izod tup was used to break the specimen.[3,4] This type of impact test has been temporarily adopted in the Author's laboratory. Sufficient information for the evaluation of this test is not as yet available; however, the results obtained are included because it is felt that they at least indicate relative trends. A complete micrographic study was made of all the sections tested. The results of the physical property tests, including the endurance limit obtained on the various test sections, are shown in Table II. The endurance test results are shown in Table III. The ratio of endurance limit to tensile strength has been calculated, as well as

TABLE II.—*Results of Physical Property Tests in Heat No. 4615.**

Heat treatment.	Tensile strength, lbs. per sq. in.	Brinell hardness.	Izod, ft.-lb.	Endurance limit, lbs. per sq. in.	Ratio, Endurance limit : tensile strength.	Tensile strength increase by heat treatment, per cent.	Endurance limit increase by heat treatment, per cent.
As cast	50,500	217	18	17,500	0.35	—	—
A	66,600	311	16	18,000	0.270	31.9	2.9
B	63,300	248	15	17,500	0.28	25.4	None
C	71,000	255	21	22,500	0.32	40.6	28.6
D	66,000	248	18	21,000	0.32	30.8	20.0

* Chemical analysis—T.C., 2.84; Si, 1.40; Mn, 0.67; P, 0.11; S, 0.059; Ni, 1.68; Cr. 0.16; Mo, 0.46; Cu, 0.15 per cent.

the percentage increases in tensile strength and endurance limit caused by heat treatment. These also are shown in Table II.

The tensile strength of the as-cast billet was 22.5 tons per sq. in. and the endurance limit was 7.8 tons, which gave a ratio of endurance limit to tensile strength of 0.347. This ratio is somewhat lower than usually shown for grey iron, but it is within the range the Author has usually experienced with sections of this size.

The normally recommended treatment for grey iron to improve the tensile strength is to oil harden and temper. That was done, of course, in heat treatment *A*. It will be noted that this treatment increased the tensile strength from 22.5 to 25.2 tons per sq. in., an increase of 32.2 per cent.

However, this increase is not reflected in the endurance limit, which in this case was raised from 7.8 to 8 tons per sq. in., or 2.9 per cent. An increase is also noted in Brinell hardness. The impact resistance is lowered from 18 to 16 ft.-lb.

The microstructure obtained by this heat treatment *A* is what may be considered sorbo-martensite and is typical of the structure obtained by such a heat treatment of an alloyed grey iron. Higher tempering temperatures would change this structure to sorbite with a corresponding drop in hardness and tensile strength. However, no further testing was done along this line because of lack of material. Heat treatment *B*, which is one attempt to obtain an acicular structure by allowing the transformation to take place at 482 deg. C., increased the tensile strength to 28.1 tons per sq. in., an increase of 25.4 per cent.; however, the endurance limit remained the same, 7.8.

The microstructure for heat treatment *B* is what Flinn and Reese[2] call acicular ferrite. The impact resistance is lowered by this treatment. In fact, this was the lowest impact value obtained in any of the heat treatments. Heat treatment *C*, where the transformation was allowed to take place at 343 deg. C., gave a tensile strength of 31.7 tons per sq. in., an increase of 41 per cent. The endurance limit was 10 tons per sq. in., an increase of 28.6 per cent. The Brinell hardness was 255, which is lower than the hardened and tempered material. An impact value of 21 ft.-lb. is the highest impact value obtained.

The microstructure for heat treatment *C* is not purely acicular but shows patches of free ferrite present.

Heat treatment *D*, which is an air cool from 870 deg. C., tempered at 567 deg. C., gave 25 tons per sq. in. tensile strength; an increase of 30.8 per cent. The endurance limit was increased to 9.3 tons per sq. in., an increase of 20.0 per cent. The Brinell hardness was greater, being 248, but the impact resistance was exactly the same as in the as-cast condition.

The microstructure obtained for this heat treatment is pearlitic with some patches of the acicular structure. However, the pearlite is extremely fine, hardly being resolved by the microscope. It resembles an as-cast structure that is frequently observed in sections much thinner than those tested. All of the foregoing testing

TABLE III.—*Endurance Limit Test Results on Heat No.* 4615.

Heat treatment.	Bar No.	Stress, lbs. per sq. in.	Cycles for fracture.	Remarks.
As cast	1	21,000	420,000	Broken
	2	18,000	652,000	Broken
	5	17,500	10,102,000	Not broken
	4	17,000	13,713,000	Not broken
	3	16,000	10,725,000	Not broken
	Endurance limit—17,500 lbs. per sq. in.			
Heat treatment *A*	1	18,500	1,387,000	Broken
	5	18,500	1,312,000	Broken
	4	18,000	12,296,000	Not broken
	3	17,000	10,191,000	Not broken
	2	16,000	10,218,000	Not broken
	Endurance limit—18,000 lbs. per sq. in.			
Heat treatment *B*	1	20,000	829,000	Broken
	2	18,000	3,172,000	Broken
	3	17,500	17,466,000	Not broken
	Endurance limit—17,500 lbs. per sq. in.			
Heat treatment *C*	2	25,000	375,000	Broken
	4	23,000	619,000	Broken
	5	22,500	13,966,000	Not broken
	3	22,000	10,160,000	Not broken
	Endurance limit—22,500 lbs. per sq. in.			
Heat treatment *D*	3	22,000	586,000	Broken
	5	21,500	1,830,000	Broken
	4	21,000	10,287,000	Not broken
	2	20,000	18,184,000	Not broken
	Endurance limit—21,000 lbs. per sq. in.			

Effect of Heat Treatment

was done with one analysis of material with one basic (as-cast) microstructure. This material was chosen for the test because the microstructure was pearlitic. However, it must be acknowledged that conclusions based on such a test may be misleading. With this in mind, further testing was carried on using material not so ideal in basic structure.

Three test sections were obtained from three experimental crankshafts cast from three different heats of a nickel, chrome, molybdenum alloyed grey iron. The size of these test sections was 8-in. O.D. by 3½-in. I.D. (cored hole) by 9½ in. long. The section thickness was therefore 2½ in. The castings were mould cooled and, because they were cast for other experimental work, they were not treated to relieve stresses.

The heat treatment, the analysis, tensile strength, endurance limit and Brinell hardness of each of these test sections is shown in Table IV. The endurance test results are shown in Table V. It will be noted that testing was done in both the as-cast and in the heat-treated condition. The testing procedure previously described was also used for this test, including a complete metallographic study.

It will be noted that two of the test sections, Heats No. 3364 and 3397, were given the normal harden and temper treatment, the difference being in the tempering temperature used. The special heat treatment given to Heat No. 3913 will be discussed separately.

It will be noted from Table IV that heat treatment increases the tensile strength of Heat No. 3364 from 20.9 to 29.2 tons per sq. in., an increase of 39.8 per cent., but the endurance limit has been reduced from 7.1 to 6.6 tons per sq. in., a reduction of 6.2 per cent.

In the case of Heat No. 3397, heat treatment raised the tensile strength from 23.2 to 35.6 tons per sq. in., an increase of 55.5 per cent.; but the endurance limit is reduced from 7.5 to 6.9 tons per sq. in., a reduction of 8.8 per cent. In these two cases, hardening and tempering gave a very substantial increase in tensile strength; but there is an actual reduction in endurance limit.

In the case of Heat No. 4615, previously described, the harden and temper treatment did not reduce the endurance limit; instead, a very slight increase was recorded.

The etched structures of these heats, Nos. 3364 and 3397, both show considerable amounts of primary cementite. The matrix also shows what, for want of a better name, may be called a pseudo-dendritic pattern.

It is believed that this pseudo-dendritic pattern is an indication of combined carbon segregation: that is, areas higher in combined carbon etch darker than those of lower carbon content, thus revealing the original dendritic pattern of the metal. When carbon is diffused more evenly throughout the matrix, no such pattern can be seen.

The heat treatment given to Heat No. 3913 was an attempt to break up the cementite particles and allow a better diffusion of the carbon throughout the matrix. Holding grey iron at 871 deg. C. for 10 hr. is not normally recommended, as graphitisation of the matrix usually takes place, lowering the combined carbon content, with subsequent lower physical properties.

The holding at 482 deg. C. was an attempt to form the acicular structure. The results obtained were believed to be of sufficient interest to include them in this report of tests.

It will be observed that the tensile strength has been increased from 21.8 to 26.1 tons per sq. in., an increase of 19.5 per cent., but there is no increase in endurance limit. The Brinell hardness has been increased from 217 to 277.

The microstructures obtained are of interest, as the graphite distribution which is approximately the same as that of other materials used for this later test. The structure of the as-cast material at 50 diameters again shows primary cementite particles and the pseudo-dendritic structure.

Conclusions

Any conclusions that may be drawn from the data offered in this Paper must necessarily be confined to the nickel-molybdenum and nickel-chrome-molybdenum alloyed grey cast irons. They must also be confined to section sizes which have cooling rates analogous to those used for the test.

Furthermore, because of the many types and

TABLE IV.—*Test Results for Heavy Sections (2½-in. Thickness) Ni-Cr-Mo Alloyed Grey Iron.*

Heat No.	Chemical analysis, per cent.									Condition.	Tensile strength, lbs. per sq. in.	Endurance limit, lbs. per sq. in.	Brinell hardness.	Ratio endurance limit : tensile strength.	Increased by heat treatment, per cent.	
	T.C.	Si	Mn	P	S	Ni	Cr	Cu	Mo						Tensile strength.	Endurance limit.
3364	3.06	1.40	0.91	0.11	0.071	1.54	0.30	—	0.49	As cast	46,800	16,000	197	0.34	—	—
3364	3.06	1.40	0.91	0.11	0.071	1.54	0.30	—	0.49	870 deg. C.—2 hr. (oil) \ 610 deg. C.—2 hr. (air) /	65,400	15,000	255	0.23	39.8	−6.2
3397	3.09	1.74	0.93	0.068	0.051	1.40	0.28	—	0.58	As cast	52,000	17,000	207	0.33	—	—
3397	3.09	1.74	0.93	0.068	0.051	1.40	0.28	—	0.58	870 deg. C.—2 hr. (oil) \ 551 deg. C.—2 hr. (air) /	79,750	15,500	293	0.20	53.3	−8.8
3913	2.94	1.32	0.99	0.089	0.055	1.39	0.30	—	0.50	As cast	49,000	16,500	217	0.34	—	—
3913	2.94	1.32	0.99	0.089	0.055	1.39	0.30	—	0.50	*	58,500	16,500	277	0.28	19.5	None

* 871 deg. C.—10 hr., quenched in oil to 482 deg. C. Held at 482 deg. C.—16 hr. Air cooled.

methods of heat treatment available to-day, conclusions must be confined to the heat treatments used. It also is realised that seven endurance tests are not necessarily sufficient to prove definitely the points offered. Nevertheless, it is believed that trends may be indicated. With this in mind the following is offered:—

1. That, in general, heat treatment to obtain high tensile strength does not give a proportionate increase in endurance limit. This is shown by Moore and Picco[1] and confirmed by the work offered there.

2. That the normal harden and temper heat treatment to attain high tensile strength does not necessarily produce any increase in endurance limit. Under certain conditions the endurance limit may be lowered by such a treatment.

3. That the original as-cast structure has a profound influence on the endurance limit obtained after heat treatment. Unfavourable structures in which the combined carbon is segregated, apparently can give a lower endurance limit than the original as-cast condition.

4. That the nickel-molybdenum and nickel-chromium-molybdenum alloyed grey irons in which no great amount of free cementite is present, can be heat treated to the acicular structure with an increase in endurance limit; however, the increase is not in proportion to the increase in tensile strength.

The Author is indebted to George Johnstone, foundry superintendent, for providing the material to carry on this investigation; and to C. F. Moore for his work in conducting the endurance tests.

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[1] H. F. Moore and J. S. Picco, "Fatigue of High Strength Cast Irons," Transactions, American Foundrymen's Association, vol. 42, pp. 525-542 (1934).

[2] R. A. Flinn and D. S. Reese, "The Development and Control of Engineering Grey Cast Irons," Transactions, American Foundrymen's Association, vol. 49, pp. 559-607 (1941); also, B. A. Timmons, V. A. Crosby, and A. J. Herzig, "High Strength Iron," "The Foundry," Dec., 1938, and Jan., 1939.

[3] FOUNDRY TRADE JOURNAL, July 22, 1943, p. 239.

[4] A. B. Everest, J. W. Grant, and J. Morrough, "The Development of a Single-Blow Impact Test for Cast Iron," The Iron and Steel Institute, Great Britain, Preprint, June, 1945.

TABLE V.—*Endurance Limit Test Results on Heats No.* 3364, 3397 *and* 3913.

Heat No.	Heat treatment.	Bar No.	Stress, lbs. per sq. in.	Cycles for fracture.	Remarks.
3364	As Cast	2	18,000	843,000	Broken
		3	17,000	1,187,000	Broken
		4	16,500	5,507,000	Broken
		6	16,250	4,805,000	Broken
		1	16,000	10,101,000	Not broken
		Endurance limit—16,000 lbs. per sq. in.			
3364	870 deg. C.—2 hr.—oil	1	20,000	380,000	Broken
	610 deg. C.—2 hr.—air	2	19,000	370,000	Broken
		3	17,000	1,272,000	Broken
		5	16,000	1,685,000	Broken
		6	15,500	1,541,000	Broken
		4	15,000	10,532,000	Not broken
		Endurance limit—15,000 lbs. per sq. in.			
3397	As cast	2	20,000	1,175,000	Broken
		3	18,000	3,378,000	Broken
		6	17,500	1,663,000	Broken
		5	17,000	11,439,000	Not broken
		1	16,000	10,249,000	Not broken
		Endurance limit—17,000 lbs. per sq. in.			
3397	870 deg. C.—2 hr.—oil	1	18,000	802,000	Broken
	550 deg. C.—2 hr.—air	2	16,000	3,039,000	Broken
		5	15,500	10,003,000	Not broken
		4	15,000	10,070,000	Not broken
		3	14,000	10,342,000	Not broken
		Endurance limit—15,500 lbs. per sq. in.			
3913	As cast	1	20,000	726,000	Broken
		2	18,000	1,317,000	Broken
		4	17,000	2,634,000	Broken
		5	16,500	10,086,000	Not broken
		3	16,000	10,213,000	Not broken
		Endurance limit—16,500 lbs. per sq. in.			
3913	870 deg. C.—10 hr.—oil cooled to 482 deg. C. held 16 hr.—cooled in air	1	20,000	696,000	Broken
		2	18,000	1,110,000	Broken
		4	17,000	2,666,000	Broken
		5	16,500	10,006,000	Not broken
		3	16,000	10,156,000	Not broken
		Endurance limit—16,500 lbs. per sq. in.			

TELLURIUM COREWASHES*

Use of tellurium base corewashes as a solution for some troublesome grey iron foundry problems, particularly shrinks, was suggested in a Paper by J. O. Vadeboncoeur, research metallurgist, Pontiac Motor Division, General Motors Corporation, Pontiac, Michigan, presented at an A.S.M. session.

The report, entitled "Tellurium Corewashes," pointed out that use of tellurium as an alloying agent in grey iron foundries has been somewhat limited, but is finding increased popularity as a means of selective control of casting structure. This control was said to be most easily achieved through the use of cores dipped or painted with washes containing the suspended metal.

The Author reported that by painting a 1-in. stripe of tellurium corewash on the core at the oil galley line where the stud bolts enter, a bad shrink on diesel cylinder blocks had been eliminated. Another shrink on a stud bolt boss on the water jacket of a lorry cylinder block was eliminated by a spot of tellurium corewash. The successful mass production of diesel cylinder liners in a horizontal position was said to have been made possible by dipping the liner cores in a tellurium wash.

These liner cores were dipped in a shallow tank immediately after removal from the core oven. A rod was placed through a vent hole which passed through the longitudinal axis of the cylindrical core. The core was revolved about the rod while immersed in the tank. An evenly applied coating was thus obtained which dried rather rapidly. It was found that best results were obtained when the specific gravity of the wash was held to 33 deg. Be.

Analysis

The laboratory analysis of the tellurium corewash paste, carrying about 20 per cent. moisture, in successful use for producing a local chilled area on several different castings, is as follows:—SiO_2, 65 to 68; Fe_2O_3, 2.0; Al_2O_3, 6.0; Te, 23 to 25 per cent., and Se and Ta, trace.

The Author stressed that in the original paste form the material is far too potent to be handled by production personnel. To overcome this the washes were mixed under laboratory supervision. One of the mixtures which met with particular success in production work consisted of 1.65 lb. of the original paste to 5.28 qts. of water. One volume of this in turn is mixed with five volumes of No. 798 plumbago wash at 27 deg. Be. Another mixture developed for its property of suspension consists of 10 per cent. tellurium paste, 5 per cent. bentonite, 5 per cent. silica flour, and 80 per cent. water. One volume of this mixture is added to four volumes of 798 plumbago wash at 27 deg. Be. The resulting mixture holds quite well in suspension.

Care in application was urged in the Paper, for if the wash is misplaced or too generously applied, the resulting chill might easily be cause for scrapping the casting. Migration of the chilled portions may also occur.

(*Continued at foot of next column.*)

IRON AND STEEL INSTITUTE

ANNUAL GENERAL MEETING

The annual general meeting of the Iron and Steel Institute will be held at the Institute, 4, Grosvenor Gardens, London, S.W.1, on Wednesday and Thursday, May 1 and 2, starting at 9.45 a.m. on the first day. There will be a luncheon for members at the Connaught Rooms, Great Queen Street, W.C.2., on May 2, at 1.0 p.m.

On May 1 the morning session will be devoted to official business; announcement of the award of the Bessemer Gold Medal for 1946; announcement of the award of the Williams Prize for 1945; induction of Dr. C. H. Desch, F.R.S., as President, and the Presidential address. Following these there will be a discussion on fuel economy in iron and steel works.

During the afternoon session there will be a continuation of the discussion on fuel economy, followed by a discussion on supersonic testing based on the following paper:—"The Detection of Cracks in Steel by Means of Supersonic Waves." By C. H. Desch, F.R.S., D. O. Sproule and W. J. Dawson. At 8.30 p.m. there is to be the first Hatfield Memorial Lecture at the Institution of Civil Engineers, Great George Street, S.W.1. It will be delivered by Dr. George B. Waterhouse, Prof. Emeritus of the Massachusetts Institute of Technology.

On May 2 the morning session will be taken up with a discussion on the overheating of steel. At 1.0 p.m. for 1.15 p.m. the meeting will close with a luncheon at the Connaught Rooms.

TELLURIUM COREWASHES

(*Continued from previous column.*)

Mr. Vadeboncoeur suggested two possible methods by which the tellurium from the corewash was introduced into the iron; elemental atoms of tellurium may diffuse into the iron, or the diffusion of the vapours themselves may be instrumental in uniting the two metals. Conclusive evidence is lacking, the Author pointed out, for either argument, but after observing the gases associated with every experiment conducted on this metal, he was inclined to favour the vapour diffusion hypothesis.

In either event, he said, once the tellurium becomes incorporated as an alloying agent within the iron, the carbides are completely stabilised for a uniform depth on the surface of the casting. The depth of the chilled area depends only upon the amount of tellurium present in the wash, and can be varied to suit the requirements of the job.

Tellurium corewashes appear to be particularly effective in preventing shrinks. The hypothesis advanced by some foundrymen to explain this property is that the viscosity of the metal is raised at the mould-metal interface. It is equally probable, the Author stressed, that the diffusion of tellurium increases the crystallisation velocity of the melt and thus causes it to solidify more quickly under the same moulding conditions.

* Abstracted from the "Iron Age."

COUNCIL OF IRONFOUNDRY ASSOCIATIONS

Modern Legislation Necessitates Increasing Activities

At the annual general meeting, held on March 14, the following Report was submitted.

The Executive and Finance Committee is happy to report a year of outstanding progress in the history of the Association.

Membership.—On April 18, 1945, the Cast-Iron Pipe Association was received into membership, but the National Association of Malleable Ironfounders resigned. It is good to be able to report, however, that the latter Association has applied for re-admission to the Council in 1946.

Accounts.—With the re-organisation involved in the transfer to Derbyshire House and membership of the Joint Iron Council, the expenditure was appreciably higher than 1944. This will be more evident during 1946 when there will be a full year's activities of the new body for which to be responsible instead of six months as in 1945.

Meetings.—The following meetings have been held by the various Committees and Sub-Committees: Annual general, 1; basic conditions of sales meeting, 1; costing, 12; council, 4; education, 2; executive and finance, 8; five-year plan, drafting, 5; technical, 2; transport advisory panel, 4.

In addition there were attendances of Council representatives at the meetings of the Ministry of Labour Special Committees on Amenities, Recruitment, Trainees, etc., and the meetings of the Federation of British Industries Grand Council, Taxation Committee, and the Traders Co-ordinating Committee on Transport.

Constitution.—An alteration in the constitution of the Council of Ironfoundry Associations agreed on June 13, 1945, was of far-reaching importance, inasmuch as it allowed for the further development of the Council in co-operation or amalgamation with any other bodies within the industry.

Joint Iron Council

The outstanding event of 1945 was the resolution made at the annual meeting held on March 21, when the Council decided to join with the Council of Iron Producers in the formation of the Joint Iron Council, and approved of the draft constitution for the new body. Mr. A. R. Knowles, O.B.E., was later appointed as Director of the Joint Iron Council, and the Secretary of the Council of Ironfoundry Associations as Joint Secretary of the Joint Iron Council. The full autonomy of the Council of Ironfoundry Associations was to be undisturbed.

Five Year Plan.—The Five Year Plan which the Joint Iron Council has been asked to prepare for the industry by the Government has been the task which has most occupied the minds of the Council, and considerable progress has been made in this direction since the activities of the Joint Iron Council began. The plan, it is hoped, will be submitted to H.M. Government in February, 1946,* and the Council appreciates the great help given in this task by the various Associations and members of the Drafting Committee.

Secretary.—The resignation of Mr. V. Delport as Secretary of the Council of Ironfoundry Associations was accepted with regret by the Council on September 28, 1945, and Mr. T. E. Parkinson, late of the Machine Tool Trades Association, was appointed as his successor, taking up his duties on October 1, 1945. Mr. Delport continues to be honorary secretary of the Costing Committee, and was appointed Public Relations Officer to the Joint Iron Council.

Fuel Committee.—The Ironfounding Industry Fuel Committee, which was formed by the Council of Ironfoundry Associations in conjunction with the Ministry of Fuel and Power, ceased its war-time activities on June 30, 1945, after some 2½ years operation. The Committee continues to function as the Advisory Fuel Panel of the Council of Ironfoundry Associations. During the period of intensive activity from November, 1942, to June, 1945, the Committee, which had three representatives of the British Cast Iron Research Association, and three of the Institute of British Foundrymen, under the chairmanship of Mr. J. G. Pearce, held 20 meetings. Fourteen Panels held 123 meetings. Visits were paid by representatives of the Committee and the regional Panels to 753 foundries to advise on fuel economy measures. The foundries concerned were responsible for two-thirds of the total output of the industry. Five reports were prepared and circulated, with the aid of the Iron and Steel Control, to all foundries in the country, the last being "Foundry Fuel—The Heat Balance as an Aid to Economy and Efficiency," by the Fuel Officer, Mr. W. J. Driscoll, who was also responsible for 33 articles in the series "Ironfoundry Fuel News" published in the FOUNDRY TRADE JOURNAL.

Labour Matters

The principal worry of the ironfounding industry continues to be labour, and the Council is well represented on the Ministry of Labour Committees dealing with this problem. The Council of Ironfoundry representatives on the Garrett Committee on Amenities are:—Mr. J. N. Deas, Thos. Allan & Sons, Limited, Thornaby-on-Tees; Mr. C. Gresty, North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne; Mr. W. A. Morton, Diamond Foundry, Luton; Mr. A. E. Pearce, Midland Motor Cylinder Company, Limited, Birmid Works, Smethwick; and on the committee for Special Methods of Recruitment:—Mr. A. Young, British Bath Company, Limited, Greenford, Middlesex.

The Garrett Committee is still engaged in fortnightly meetings, but has not yet published any recommendations. The Committee on Special Methods under the Chairmanship of Mr. H. B. Clark has proved itself a

*The plan has been submitted.

Council of Ironfoundry Associations

virile body and has been responsible for the recent direction of redundant non-ferrous workers into the ironfounding industry. It has also agreed on the representations of the Council of Ironfoundry Associations to produce a documentary film of the industry in order to attract labour. Further developments can also be expected regarding the importation of foreign labour.

Education.—The publication of the booklet "The Future for Boys in the Foundry," has been received with enthusiasm throughout the country and many copies have been sent abroad, where a problem exists similar to that of our own. Educational and technical authorities have co-operated in the distribution, and interest has been aroused in the right quarters. Film slide lectures are now available of the photographs embodied in the leaflet, on request from suitable authorities. Whilst it has not been possible to re-open the British Foundry School in 1945, difficulties with regard to premises have been overcome and it is hoped to re-open as early as possible in 1946. This will be the first national college for an industry under the new education arrangements.

Technical Committee

The Technical committee of the Council of Ironfoundry Associations was merged into the Advisory Technical committee of the Joint Iron Council in September, 1945, and was re-constituted. The committee has submitted a Report on Fuel in Ironfounding which has been embodied in the Five Year Plan to the Government. The committee has recommended, and the Council has protested to the Factory Department, against the proposed new regulation prohibiting the use of siliceous parting powders. It is a well-known fact that all parting sands contain silica including seashore sand, and the use of these in foundries is normal practice. A reasoned memorandum on this subject with suggestions has been forwarded to the Factory Department.

Costing Committee.—The Costing Committee has completed its investigations and is now proceeding with the final revision of the Report to be submitted to the Council. Since the last annual general meeting the Costing Committee has held six week-end meetings at Manchester, Birmingham, London and Sheffield during which the committee carried out its investigations on the Friday and Saturday. A Drafting sub-committee held two meetings at Leicester, and further meetings took place at intervals between individual members to discuss certain specific points. The problem set to the committee is complex, but it is hoped that the Report will be completed in its final form by July 30, and that the system will cover the requirements of all sections of the industry.

Transport Advisory Panel.—The Transport Advisory Panel which was set up 2 years ago has met from time to time during the year, as considered necessary. It issued to members during that time four bulletins dealing with a wide range of transport matters—to mention a few of them—the Carriage Paid Order, railway claims, conditions of carriage by road, Defence Permits and "C" licences, wood packing, stoppage of goods in transit, post-war transport problems, etc.

In addition to this, members are making more and more use of the services offered them by writing on transport problems which arise in their own businesses from time to time; where it is not considered necessary to call a meeting of the Panel specially, such communications are circulated to the chairman and the members to obtain their views, which are then co-ordinated and a reply sent to the member. The Panel has been able to give constructive help and advice in many such cases. There are a number of firms in our membership, the extent of whose traffic probably does not warrant the services of a full time Transport Officer, and such firms can, if they wish, obtain a good deal of assistance and advice from the Panel, and it is hoped that more members will make use of these services because the chairman and members of the Panel are most anxious that the fullest use should be made of the facilities offered.

British Investigation Teams in Germany

As soon as it became clear that visits to Germany on the part of technical experts would form part of Government policy, the C.F.A. arranged to secure nominations through the constituent Associations. The necessary organisation was undertaken by Mr. J. G. Pearce, Director, B.C.I.R.A., who himself visited Germany in another connection in October, 1945. Finally, four teams, drastically curtailed in numbers by the Ministry, were arranged, dealing respectively with centrifugal castings, engineering grey iron castings, malleable castings and light castings, and the teams duly left in January, 1946, and have now all returned. An ingot mould team may also be arranged. Consideration is being given to the best ways of dealing with the results and with the enquiries which inevitably follow the dissemination of such information.

Conditions of Sale

The draft conditions of sale which have been considered by the Council's legal advisers are now being re-considered by the sub-committee before any further action is decided upon.

Solicitors.—Slaughter & May, 18, Austin Friars, London, E.C.2, have been appointed as official solicitors to the Council.

Administration.—The work of the Council has been greatly increased during 1945. Up to the formation of the Joint Iron Council, and having regard to the negotiations which preceded it, the administrative activities were far in excess of the available staff capacity. The Executive were prepared therefore, for a greater expenditure account when the new Secretary was appointed and the new staff arrangements completed with the occupation of Derbyshire House. The new administration will, of course, result in greater benefits to the industry from its activities and the interests of ironfounders will be studied to the utmost. The end of 1945 sees the ironfounding industry in a stronger and more consolidated position than ever before in its

(*Continued at foot of next column*).

WASTERS DUE TO PATTERN EQUIPMENT

By "CORONER"

Patterns sent to the foundry from outside customers are not always constructed to favour either the easiest or safest methods of production, hence wasters occasionally occur through the fault of the moulder or coremaker. Apart from such obvious wasters as those which are dimensionally inaccurate, or of those which are of wrong "hand" scrapped castings due to other causes, can sometimes be traced to faulty pattern equipment.

As an example, a fairly complicated cylinder casting consisting of two bores, crankcase portion, valve chest and ports, was scrapped due to a piece of core washing off and cutting through the side of the casting. Naturally the inspector blamed the coremaker, but he, to justify himself, drew attention to the fact that the core boxes were so constructed that he had to produce the core in halves through the bores, and the part which washed was only about ¼ in. thick and forming a semicircular piece about 1 in. wide and 6 in. internal dia., whereas in the other half core the counterpart of this piece was in the region of 4 in. thick.

This thin portion, it was contended, was very delicate and was liable to be burnt unduly when baking the heavier part of the same core, and was also very prone to warping, especially when the metal flowed around it. This warping, and the possibility of the core being rotten, were the causes of the waster.

As a safeguard it was proposed to modify the core-boxes so that instead of this delicate piece being carried on a comparatively heavy core, it should be made integral with its counterpart on the other half core. This entailed making a stepped joint in both cores, instead of a flat plain joint, but this was easily overcome by using special drying plates.

Since the modification no trouble from this cause has been experienced and this case is a very good example of occasions where trouble is at first blamed on the wrong department. It also illustrates the necessity of close co-operation of foundry with pattern shop before pattern equipment for complicated work of this nature is undertaken.

COUNCIL OF IRONFOUNDRY ASSOCIATIONS

(*Concluded from previous page.*)

history. The form of organisation which is now at the service of members in the Joint Iron Council is considered professionally to be the desideratum of trade associations' progress, and the good which it can do for the industry cannot be estimated. In domestic matters the Council of Ironfoundry Associations is still autonomous, anxious and eager to carry out the wishes of the industry. The prestige of the Council of Ironfoundry Associations in all circles stands high, and it is up to the constituent associations to make the fullest possible use of the Council of Ironfoundry Associations if they wish it to be of service to them.

[Signed] T. E. PARKINSON,
Secretary.

A.F.A. NOMINATES NEW OFFICERS

Mr. Sheldon V. Wood, of Minneapolis, has been nominated for the presidency of the American Foundrymen's Association in 1946-47. He is president and manager of the Minneapolis Electric Steel Castings Company. Mr. Wood succeeds Mr. F. J. Walls, of the International Nickel Company, Inc., Detroit.

Mr. Max Kuniansky, vice-president and general manager of the Lynchburg Foundry Company, Lynchburg, Va., is to be the new vice-president. The following have been nominated as directors to serve for three years: Mr. Horace A. Deane, vice-president, American Brake Shoe Company, New York City; Mr. J. E. Kolb, pattern shop superintendent, Caterpillar Tractor Company, Peoria, Ill.; Mr. H. G. Lamker, superintendent of foundries, Wright Aeronautical Corporation, Paterson, N.J.; Mr. Bruce L. Simpson, president, National Engineering Company; and Mr. Stowell C. Wasson, manager, National Malleable & Steel Castings Company, both of Chicago.

NATIONAL EXHIBITION OF INDUSTRIAL DESIGN, 1946

The Council of Industrial Design, Tilbury House, Petty France, London, S.W.1, have now issued a notice for the further guidance of manufacturers who wish to exhibit their goods. Unlike most exhibitions, the actual exhibits are to be selected by a committee, and there is to be no charge for space. Moreover, the names of the makers will not be displayed in the goods but will be available by other means.

The Exhibition is to be called "Britain Can Make It"—apt for home consumption but probably inappropriate in the non English-speaking overseas markets, for it would indeed be a coincidence if the Polish or Arabic words for "take" and "make" really rhymed.

PUBLICATION RECEIVED

Refined Ferro-Manganese Alloys for Steelmaking. Published by St. Lawrence Alloys & Metals, Limited, Beauharnois, Quebec, Canada.

This booklet, one of a series of technical publications available from the company, describes the use of refined ferro-manganese as a furnace or ladle addition for improving the cleanliness and uniformity of structure of the metal produced. It details the advantages of using refined ferro-manganese in the production of a variety of steels. Charts designed to facilitate calculations in the addition of ferro-manganese alloys are included, but the reviewer thinks they tend to complicate extremely simple arithmetic.

It is stressed that this series of brochures is available in several languages, yet the reviewer thinks better service would be done by listing the agencies which the St. Lawrence concern has established overseas.

MR. EDWIN COMMINS has been appointed secretary of the Association Technique de Fonderie de Belgique. His address is 22 rue d'Harscamp, Liége.

INDUSTRIAL SIGNIFICANCE OF THE BASIC CHARACTERISTICS OF MAGNESIUM

Dr. J. D. Hanawalt, director of metallurgical research of the Dow Chemical Company, Michigan, has made some interesting comments about the German magnesium industry, as a result of his visit to Germany last year. The following is an extract of his report taken from "Modern Metals."

"It has been very commonly thought and stated in the United States that Germany used magnesium much more extensively than the United States because they did not have enough of other metals; in other words, that the magnesium industry in Germany was operating under some very special and artificial economy. In Germany, magnesium had to face strong competition from all other metals, particularly from a highly developed aluminium industry, and consequently magnesium was used only when it was the best material for the purpose.

"Germany was, in general, somewhat below the United States in metallurgical development and also in processing techniques, with a few specific exceptions such as in die casting and forging. However, Germany had big advantages in design experience and variety of service experience due to their earlier introduction of magnesium industrially and their more extensive exploitation of its inherent characteristics. The Germans, by 1938, were using 1,200 tons of magnesium every month in the textile industry alone. They made considerable use of magnesium for wheels and for engine and transmission housings on lorries and buses. Practically all passenger cars used a magnesium oil pump which was cost competitive because of a good combination of the operations of die casting and machining. Fans, pulleys and other parts of cars were also of magnesium. Forgings, large and small, were in use in German aircraft. A very large forging was used by the Ordnance Department for cannon mounts.

"At one foundry in Germany last summer, I met a superintendent with a vivid appreciation of the resilient properties of magnesium. At most of the places I visited, the Germans were simply nervously waiting for someone to tell them what to do, but this man was busying himself by casting magnesium bicycle tyres. He said that with a shortage of rubber they would soon be needed. I had to admit that if he was determined to make metal tyres magnesium was the best metal for the purpose.

HYPODERMIC NEEDLE TUBING

A length of extremely delicate cold-drawn tubing with an outside diameter of 0.006 in., and 0.0035 in. bore, has been produced by the Tube Investments group of engineering industries at the Accles & Pollock, Limited, works in Oldbury, Birmingham. A pound of the tubing would extend over 8½ miles. The experimental production has a bearing on the development of stainless-steel tubing for hypodermic needles.

DEATH OF MR. HARRY WINTERTON

As briefly recorded in our last issue, the death took place last week of Mr. Harry Winterton, managing director of William Cumming & Company, Limited, of Glasgow, Chesterfield and Deepfields. In his early days Mr. Winterton was in the entertainment business and travelled all over Europe. His first connection with the foundry industry was when he was appointed by the late Mr. William Cumming as his Midland representative. He soon made himself familiar with the technique of foundry practice, as his business trips took him into practically every foundry in the country, as well as in Canada and the United States. He joined the Institute of British Foundrymen in 1906—two years after its creation—and his record as a consistent supporter of both the annual meetings and international congresses is probably unsurpassed. He was elected President of the Institute in 1936. He was well qualified for this honour, as he had presided over the Scottish branch in 1929. Moreover, that year he was also President of the Foundry Trades Equipment and Supplies Association. In 1933 he presided over the Refractories Association, and was that year elected a Bailie of Milngavie. Though he attained the age of 75, he was never an old man. He read without the aid of spectacles and was extremely energetic. His son, Mr. H. T. Winterton, is manager of the Chesterfield branch of the business; and to him and Mrs. Winterton, who is almost as well known as was her husband, we extend our sincere sympathy. One of his ambitions was the placing of foundry supplies on a higher level, both technically and commercially, and it is in this direction that he will be best remembered.

A WELCOME REVIVAL

It is with distinct pleasure that we announce that "La Fonderie Belge," the official bulletin of the Association Technique de Fonderie de Belgique, has recommenced publication. The first issue, dated January-February, is very largely taken up with a recapitulation of the papers read before the Paris Autumn Foundry Congress, but in addition there is an important article by Professor Portevin, which points out a number of fallacies in the well-known Maurer diagram. The magazine is published from 22 rue d'Harscamp, Liége, and apparently it is only to be obtained through membership of the "Association Technique."

GERMAN TECHNICAL REPORT

From a lengthy list of reports made by Commissions visiting German industrial and scientific establishments, there is but one of direct interest to the foundry industry, and that is BIOS 238—Visit to Mahle Kom. Ges. Pragstrasse, 26, Stuttgart, Bad Cannstadt. It is entitled "Aluminium Alloy Pistons Pressure Die Castings, Magnesium Sand Castings, Remelting of Aluminium Scrap." It costs 3s. 2d., post free, from H.M. Stationery Office, York House, Kingsway, London, W.C.2, and is available for consultation at the principal public libraries throughout the country.

SPECIFICATION, DESIGN AND PRODUCTION OF IRON CASTINGS FOR VITREOUS ENAMELLING*

BY JOHN W. GARDOM, M.Cons.E., A.M.I.Mech.E.

INTRODUCTION

Cast iron is, and will continue to be, an important material to the vitreous enameller. Compared with other ferrous metals it is cheap and easily fabricated, and components of more or less complicated design can be produced rapidly in large quantities. Cast iron possesses unique properties which give it advantages over other metals so far as the application of enamels is concerned. It is, for example, more resistant to distortion under heat during the enamelling operation than sheet metal, and its capacity for damping vibration make it less resonant and give a more solid job. Its rigidity is a useful feature, as there is much less danger of cracking and chipping of the enamel coat on iron castings during handling than with components in metal, which are easily bent.

A disadvantage of iron castings in the past, from the enameller's viewpoint, has been lack of uniformity from batch to batch, for this metal, in spite of its simplicity of production, is metallurgically highly complex. Recently there have been remarkable developments in foundry technique and metallurgical knowledge, and in modern quantity production foundries, where control is exercised over all operations, it is now possible to produce better, sounder, cleaner and more uniform castings. This fact, coupled with the large variety of attractive enamel finishes which have become available, ensures that iron castings will find a large field of uses for many years to come.

Design of Castings

When the very wide range of iron castings which are vitreous enamelled is considered, varying from, say, a clothes hook to a bath and from a chemical pan to a door frame for a cooker, it is impossible to lay down any golden rules for design. Those rules which can be put forward are simple commonsense and incidentally are just as important to the founder as they are to the enameller. It should be made clear that the ironfounder is in no way responsible for the unfortunate design of some castings which are required to be enamelled, as a casting designed for ease of enamelling is at the same time simple to handle in the foundry and *vice versa*.

For example, the enameller knows that to obtain a satisfactory result on metal of $\frac{3}{16}$ in. thickness, different treatment is needed from that for the same metal in a 1 in. thick section, yet the designer often has no hesitation in putting a 1-in. thick boss on a $\frac{3}{16}$-in. plate. Castings of uniform section are as much desired by the ironfounder as the enameller. The tendency for castings to warp and crack in both the foundry and the enamelling shop can be reduced by avoidance of sharp corners, close curves and abrupt changes in section. Every effort should be made to secure a casting of uniform section and much can be done in this direction in the coring out of hinges, catches and bosses to prevent the occurrence of thick pads of metal. Where it is necessary to strengthen a casting by the use of webs or ribs, a large number of small ribs is always preferable to a few of heavy section and such changes can usually be made without loss of strength. Finally, the ideal casting for vitreous enamelling should be designed so that it may be easily cleaned. With the introduction of modern rapid cleaning methods, increased attention to this point would often reduce cleaning costs and at the same time result in a better and more pleasing article.

The Specification of Castings

It has been said that any iron castings can be successfully enamelled, and this is probably true. Cases have been brought to the Author's notice where a casting which has given trouble in one enamelling shop has been taken away and processed perfectly elsewhere. This is not necessarily proof that the casting is suitable for enamelling. If every casting could be treated individually and annealed and shot-blasted until a satisfactory result were obtained, there is no doubt that any kind of cast iron could eventually be enamelled. In the average enamelling shop, however, especially where this is operated on quantity production lines, the properties of the castings must lie within fairly narrow limits. The main requirements of an iron casting for vitreous enamelling are that it shall be clean, sound and grey.

Annealing

It is not proposed to discuss the normal cleaning methods adopted for grey-iron castings, but it is thought that at this point something should be said on the question of annealing which is essentially a "cleaning" process. If a casting of suitable finish and composition be taken from the foundry, correctly cleaned by shot-blasting or other methods, it can usually be successfully enamelled without preliminary annealing. This is not, however, often possible in practice and castings may have to be stored for long periods before processing. In such cases annealing is a safeguard, as it will remove any traces of rust, oil, grease or other carbonaceous matter and thus ensure trouble-free enamelling. The structure of cast iron is such that oil and grease, etc., can penetrate to an extent that they are not readily removed by normal cleaning methods.

*A Paper read before a joint meeting of the Midland section of the Institute of Vitreous Enamellers and the Birmingham, Coventry and West Midland branch of the Institute of British Foundrymen. In the absence of the Author, who is president of both Institutes, the Paper was read by Mr. L. W. Bolton. Mr. W. Todd presided.

Specification, Design and Production

Annealing also serves another important purpose, in that it produces in the iron a uniform structure of a type most suitable for enamelling. For this reason, when there is any cause to believe that the castings are likely to vary in properties, either among themselves or from batch to batch, annealing prior to enamelling is very beneficial, as it will remove, or tend to smooth out, these variations.

Soundness

So far as soundness concerns the enameller, this means freedom from surface defects such as blowholes, sand and slag holes, etc., as well as internal porosity. These are entirely matters of foundry control and inspection, but the modern mass-production foundry where sands of controlled properties are used and where the moulds are made under standard conditions on machines, defects of this type should be at a minimum. Rigid inspection should ensure that castings showing such defects do not reach the enameller. The cause and prevention of foundry defects has received special study during the past few years and founders generally are now in a better position to supply sound castings than ever before.

Composition of Castings for Enamelling

The final, and possibly the most important requirement, is that the casting shall be grey in fracture, that is, that its chemical and physical composition shall be correct. By a "grey fracture" is meant that no "chill," "mottle" or "white iron" is present. Chilled or white irons have a much greater tendency to crack when rapidly heated than grey iron, but, quite apart from this, the presence of white iron in a casting which is to be enamelled is very undesirable because of the danger of a reaction which may take place between such metal and the enamel at the firing temperature and result in the formation of blisters. A thorough preliminary annealing of chilled castings will do much to remove this danger.

Hard spots of white iron can be caused by the use of sand which is too damp, casting metal into a section which is too thin, or by the use of metal of unsuitable composition. Here again, these are questions of foundry control, but of the three above causes, composition is the most important. The analysis of iron castings for enamelling should be controlled within fairly narrow limits if troubles such as cracking, warping and blistering are to be kept to a minimum, and because of this it is as well for the enameller to know something regarding the influence of the common elements present in cast iron on the properties of the metal.

Carbon

Carbon can be present in cast iron in two forms:—(1) As free carbon, known as graphite, or (2) in combination with the iron when it is known as combined carbon. From the viewpoint of ease of enamelling, the more of the carbon present as graphite and the less present in the combined form, the better. There is, however, one important proviso to this statement and that is, graphite in very coarse flakes must be avoided. For the most satisfactory results the graphite should be in a *fairly* fine state of division. (*Very* finely divided graphite makes the metal "tight" and increases the tendency for it to crack when rapidly heated.)

When the total amount of carbon present is high there is a danger that very coarse graphite will be formed. With abnormally high carbons some of this graphite is thrown out of the metal as it cools in the mould and may be deposited on the surface of the casting, where it can be easily recognised in shining flakes. This graphite is known as "kish" and, if present on the surface of a casting for enamelling, is a definite sign that the carbon content of the iron is too high. Kish graphite will cause blistering of the enamel. Even if the kish on the surface of the casting be removed by thorough cleaning and sand blasting, its presence indicates that the graphite in the iron will be very coarse and that trouble in enamelling will result.

The amount of carbon which can be present in cast iron without any chance of kish graphite being produced is dependent on the proportions of other elements present, notably silicon and phosphorus. The amount of combined carbon in the iron controls the increase in the volume of the metal which takes place when it is first raised to a high temperature. This "growth," or increase in size, results from the breakdown of the combined carbon and varies with the proportion of combined carbon present. In normal iron the total increase in volume varies from 1 per cent. to a maximum of 2 per cent. on an iron containing 1 per cent. combined carbon.

Silicon

Silicon is essential in grey cast iron because its presence in sufficient quantities ensures that a large proportion of the carbon exists as graphite and not in the combined form. When silicon is present to excess, it makes the castings brittle in the cold and liable to crack when rapidly heated. High-silicon irons have an increased resistance to bending and distortion at high temperatures.

The amount of silicon present should be arranged to suit the average section thickness of the castings, and in the light castings used in the manufacture of cookers and stoves where average section thicknesses vary from $\frac{1}{8}$ in. to $\frac{1}{4}$ in., a silicon content between 2.5 and 3.0 per cent. is usually satisfactory. Because of the increased danger of cracking with high-silicon iron, it is not advisable to exceed, say, 3.2 per cent. silicon even on the lightest type of castings. On the other hand, for castings which are all $\frac{1}{8}$ in.-$\frac{5}{32}$ in. average thickness a silicon of not less than 2.75 per cent. is required to avoid a high combined carbon.

Phosphorus

Phosphorus is an important element in light castings because it imparts fluidity to the metal. In castings of very light section a relatively high phosphorus is necessary so that the molten metal will "run" and completely fill the mould. Because of the increased fluidity of a highly phosphoric iron, casting temperatures can be reduced and this gives a cleaner casting

with less chance of sand being burned in. Like silicon, phosphorus increases the brittleness of cast iron in the cold and its resistance to bending and distortion at elevated temperatures. High-phosphorus irons have an increased tendency to crack if subjected to rapid changes in temperature, and this is especially the case if the casting is of complicated or non-uniform section.

Considerable differences can be observed in the average phosphorus contents of similar castings produced in this country and in the U.S.A. and Canada, but this difference is largely due to the availability of phosphoric irons in the two countries. The main iron ores in Britain are higher in phosphorus than those which are readily available in many ironfounding centres in America, and the use of lower phosphorus contents in the latter country is not always a matter of choice but often because the higher phosphorus irons would be more expensive on account of the long distances the phosphoric pig-iron would have to be carried. Very light and small castings are often made in British foundries and quite successfully enamelled with phosphorus contents up to 1.6 per cent. For larger and more complicated castings a lower phosphorus content is advisable and 1.0 to 1.2 per cent. is a satisfactory range for a wide variety of work. In special cases where very large castings are to be rapidly and non-uniformly heated, a lower phosphorus may be beneficial in making the metal more resistant to cracking.

Sulphur and Manganese

Sulphur is present in all cast iron and is largely derived from the coke used in the melting process. It exerts a very pronounced influence on the condition of the carbon and, if excessive by even a small amount, it may cause the metal to become chilled, mottled or white in fracture. Manganese when present alone has a similar action to sulphur in a much milder degree, but its first action is to neutralise the effect of the sulphur present. In normal grey irons, if the manganese content is approximately 0.4 per cent. more than the sulphur, no trouble from the latter element will arise.

Manganese in excess of that required to neutralise the sulphur has no beneficial influence on the metal so that a large surplus should be avoided. Because of the very pronounced deleterious action of sulphur, however, a small excess of manganese is desirable. The sulphur content of normal light castings iron is usually in the range of 0.08 to 0.12 per cent. and a manganese content of 0.5 to 0.6 per cent. then gives the most satisfactory results.

Influence of Silicon and Phosphorus on Carbon Content

It has been shown that for the average light casting used for enamelling, the silicon and phosphorus should be in the following range:—Si 2.5 to 3.0 per cent., and P 1.0 to 1.2 per cent. If the silicon and phosphorus contents of any iron are added together, multiplied by 0.3 and the result subtracted from 4.3 per cent., the figure obtained is the upper safe limit of the carbon content to avoid the production of coarse and kish graphite.

Assuming therefore that an iron contains 3.0 per cent. silicon and 1.2 per cent. phosphorus, then 3.0 + 1.2 = 4.2 per cent; 4.2 × 0.3 = 1.26 per cent., and 4.3 − 1.26 per cent. = 3.04 per cent.; the highest carbon content which may be expected to give good enamelling results is therefore 3.0 per cent. The pronounced effect of these two elements on the carbon content of the iron is seen if another iron is considered having a silicon content of 2.5 per cent. and a phosphorus of 0.8 per cent. In this case 2.5 + 0.8 = 3.3 per cent.; 3.3 × 0.3 = 0.99 per cent., and 4.3 − 0.99 = 3.3 per cent. The reason why many castings which are successfully enamelled in the U.S.A. have higher carbon contents than are usually met in this country is that the phophorus content of the metal is lower. High carbon, of itself, increases the tendency of the iron to be grey and free from chill and this enables the silicon content also to be reduced.

Other Effects of Silicon and Phosphorus

Silicon encourages the formation of graphite and reduces the tendency for combined carbon to be present. When a cast iron contains appreciable proportions of this element, the combined carbon present in the as-cast condition is rapidly broken down to graphite as the metal is raised to the annealing or enamelling temperature. Carbon in the combined form, when present at the surface of a casting, reacts with enamel at high temperatures. This reaction produces gas which can result in blistering of the enamel coat. It is, therefore, important that the smallest possible amount of combined carbon is present in the surface layers at the enamelling temperature. Further, as the reaction takes place only between the enamel and combined carbon in the surface layer of the metal it can be completed rapidly and without damage to the final finish obtained, *so long as new combined carbon cannot diffuse to the surface of the metal to continue the reaction.* In other words, if this reaction takes place and is completed in the early stages of firing, there is then time for the blisters formed to heal over and for a satisfactory finish to be obtained.

When an ordinary grey cast iron is heated any combined carbon present tends to break down as the temperature is raised and be deposited as graphite. This action continues until a certain temperature is reached. At this temperature, which is known as the critical temperature, the graphite begins to go into solution in the iron and the combined carbon so formed is able to diffuse through the metal. Silicon has an important influence on the critical temperature and the more of this element present, the higher is the temperature at which the graphite goes into solution. For example, with a silicon content of the order of 0.5 per cent., such as is found in mild steel and malleable iron, the critical temperature is approximately 700 deg. C. With 2.0 per cent. silicon present the critical temperature is about 760 deg. C. and is increased with 3.5 per cent. silicon to 810 deg. C. To raise the critical temperature to 900 deg. C. about 5.0 per cent. of silicon is needed and this amount makes the metal brittle and prone to cracking if rapidly heated.

Specification, Design and Production

Influence of Phosphorus

When cast iron is to be enamelled at high temperatures the influence of phosphorus must also be considered. The constituent formed by phosphorus has a melting point far below that of the iron itself and if phosphorus is present in any appreciable quantities it is unwise to heat the metal above a temperature of 950 deg. C., as otherwise the phosphorus constituent will begin to melt. As already stated, some phosphorus is necessary in cast iron which is to be poured into thin sections in order to give the necessary fluidity, but with satisfactory foundry control over melting and pouring conditions there is no absolute necessity for phosphorus to exceed, say, 0.3 per cent. With phosphorus contents of this order no danger from melting will arise at temperatures up to 950 deg. C.

It will be seen that when ordinary vitreous enamels are applied to grey-iron castings of a composition within the range which has been discussed, the firing temperature is either below the critical temperature or so little above it that there is insufficient time for large-scale diffusion of combined carbon towards the surface layers. With high fusion point enamels of the type used in the chemical industry there is a considerably increased danger of carbon going into solution at the firing temperature and rapidly diffusing towards the surface. The reaction which results in blistering of the enamel is therefore much more likely to occur and persist to an extent which will prevent blisters, which may form in the first stages of firing, from healing over. Various methods of overcoming these problems exist, such as thorough preliminary annealing, which tends to remove the carbon from the surface layers, and the use of alloys to prevent rapid solution and diffusion of the carbon. The difficulties have, however, by no means been completely overcome and the development of special iron for the application of high-fusion point enamels is a matter where research by competent investigators should be undertaken.

DISCUSSION

Having read the Paper, and shown a series of slides explaining it, MR. L. W. BOLTON then answered a series of questions put to him by members of both organisations. He thought that definite proof could be brought to show that combined carbon when present in any appreciable quantities in cast iron or steel would react with enamel at the firing temperature. He was unable to state definitely what gas was produced, though it was possibly a hydro-carbon. Recent American work had shown that blistering could result from hydrogen in the metal, but he was not at all convinced that this was a major cause of this trouble. Some contamination of cast iron by hydrogen would always occur during cupola melting arising from moisture in the blast, etc. It was known, for example, in the production of certain critical castings, that on days of high humidity the increased hydrogen content of cupola melted metal caused a greater tendency to chill. No evidence had, however, been produced that castings made on days when humidity was high showed an increased tendency to blister. Even if this effect were noticed, he would be inclined to attribute it to increased chilling rather than to the actual hydrogen present.

In obtaining castings with uniform enamelling properties the most important thing was to produce them under uniform conditions, and in the modern quantity production foundry a much greater measure of control over all operations could be obtained than had previously been possible. In the past, many of the difficulties experienced in obtaining satisfactory enamelling of cast iron was due to variations in the properties of different batches of castings. There was no doubt that the question of pouring temperature was important. A high casting temperature tended to give a poor surface, and, generally speaking, was not necessary with the high-phosporus irons used for vitreous enamelling. Too low a temperature could cause chilling and hard spots so that the pouring temperature should be controlled within fairly narrow limits. In any case, however careful the control, rigid inspection of all castings for enamelling was necessary.

Effect of Coal Dust

A casting to be enamelled should be free from burned-on sand and coal dust. Some foundries producing large castings for enamelling would not use coal dust, but for light castings an addition of coal dust improved the properties of the sand and gave a better strip. He was doubtful if coal dust when used in normal amounts could have any deleterious effect on the properties of the metal at the surface of a casting. Annealing could be relied on to remove all traces of coal dust. Up to fairly recently many foundries had no control over the sand they used, but the regular routine testing of sand was increasing, especially in the mass-production foundry. By this means it was possible to maintain sand of a certain standard which contributed to the production of uniform castings. It was not possible to give details of a suitable standard, as this depended on the sand available and the class of work. It must be determined for a particular sand, and once determined could be adhered to by proper control methods.

MR. A. J. SHORE said his firm used to get a smooth skin on castings by including a rather large amount of fine coal dust in the moulding sand. They came to the conclusion that they secured better enamelling results with not quite such a good skin but a rather more open surface. He understood Mr. Bolton to say that graphite could be satisfactorily enamelled. Was it not possible, however, that shot-blasting removed the graphite flakes from the surface of the casting, so as to give a continuous surface of almost pure iron?

Removal of Graphite

MR. BOLTON said at one time it was thought that graphite was easily removed from cast iron by abrasion, but he did not believe it would be easy to remove the

whole of the graphite from the surface. In reply to another questioner Mr. Bolton said that if there were any danger of hard spots containing free carbide, an annealing temperature of at least 850 deg. C. would be necessary to get rid of them. For removing carbonaceous matter from the surface a lower temperature could be used. In the former case the actual time at the temperature was important, and if white iron were present at least half an hour at full temperature would be needed followed by a relatively slow cool through the critical point. The only way to determine whether a certain annealing time was sufficient was to check up on the structure.

Agreeing with Mr. Flavel, Mr. Bolton said that some form of rapid control test for the metal was essential in producing castings with uniform properties. Usually a wedge test which indicated the chilling tendency of the metal would give all that was required. A test examination, say, every half hour, would show whether the metal was consistent.

On the proposition of MR. THOMAS, the meeting accorded Mr. Bolton a hearty vote of thanks for reading the president's Paper, and also for answering the various questions.

OPTICAL PYROMETERS

A critical examination has been made of five models of commercial portable optical pyrometers of the disappearing-filament type, with reference to the design of the lamp, the optical system, the monochromatic and neutral filters, and the measuring system. The results are published in a Paper entitled "The Design and Performance of Some Commercial Optical Pyrometers of the Disappearing-Filament Type," by C. R. BARBER, B.Sc., presented to the Iron and Steel Institute. It is shown that in many cases the lamp filaments are too short to be free from end-effect, and the advantages of the use of a flat-filament in this and other respects are discussed. The size and position of the diaphragms of the optical system were in some examples not in accordance with those necessary for obtaining perfect disappearance of the filament. The transmission curves of the monochromatic and neutral filters are given, and the requirements of the combination of the two filters are examined. A current or voltage calibration of the lamp may be employed and the advantage of the latter for short filaments is pointed out. The potentiometer method used in one pyrometer is said to have considerable merit.

DIETERT MOISTURE TELLER

THE RIDSDALE MODIFIED DESIGN

The previous design of Moisture Teller consisted, briefly, of a fan which blew a stream of air over an electrically heated element and then through a wide pan fitted with fine gauze on which a 50-gm. sample was spread in a thin layer. The hot air stream flowed downwards through the sand and escaped through the bottom of the pan fitted with a fine mesh gauze.

The new design reverses the direction of flow of hot air. It is now blown upwards through the fine gauze of the pan and then through the thin layer of moulding sand spread on the gauze. In this way the gauze is prevented from getting choked with fine particles, and mechanical loss is avoided by having a much deeper pan than formerly, fitted with a lid having a small outlet about 1½ in. dia. which is covered by a closely fitting cap (on the top of the lid) to which is soldered a layer of fine gauze. The sample dries in between 2 and 4 mins., according to the nature of the sand, and the pan is then transferred to a cooling box which rapidly cools the pan before it is weighed on a special balance having a sliding rider on a beam, so graduated that the percentage of moisture may be read from it directly.

The special features of the new design embody a fan fitted with a sturdy electric motor running on self-lubricated bearings which will withstand the heat which is generated. This is an important advantage which overcomes trouble due to inadequate lubrication. The cooling box is made of aluminium, and the top part comes into close contact with the inside of the pan and the sand sample, whilst the bottom half is a close fit to the outside of the pan, giving maximum cooling effect. The whole apparatus is more robust and durable than any previous model and enables the moisture of moulding sands to be determined accurately in a few minutes. The complete outfit, including three drying pans and special balance, enables moisture determinations to be made at the rate of between 12 and 20 per hr., depending upon the type of sand used.

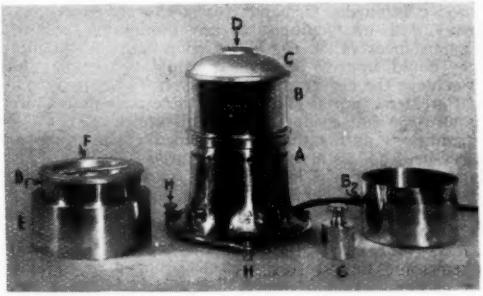

FIG. 1.—SAND MOISTURE TELLER—NEW DESIGN.
(A) Main body of heater and motor which drives a stream of hot air upwards; (B) Pan fitted with fine gauge on which a thin layer of sand is spread for drying; (C) Metal cover; (D) Perforated cap; (E) Aluminium cooling box; (B1) Pan in course of being cooled rapidly; (B2) Third pan with 50 gm. sand sample ready for drying; (3) Lid of cooling box fitting inside pan; (G) Counterpoise of pans; (H) Levelling screws.

The apparatus has been developed by Ridsdale & Company, Limited, 234, Marton Road, Middlesbrough, who are the British agents for the H. W. Dietert Company, of Detroit.

DIFFICULTIES OF CONVERSION TO PEACE PRODUCTION

RAW MATERIALS AND TRANSPORT

Speaking of the company's conversion from war to peace production at the annual meeting of Dorman, Long & Company, Limited, LORD GREENWOOD (chairman) said that the transition, though free from violent disturbance, had presented many problems. Their chief difficulties had been associated with supplies of essential raw materials and transport. At times these had been really serious. They needed a much freer intake of foreign ores, and here the transport factor made itself felt. Shortage of shipping had interfered with deliveries of ore; and it had also retarded overseas shipments of their finished products. The very difficult situation confronting the railways had increased their difficulties, and shortage of wagons, and inability of the railways to accept traffic, had caused such excessive stocking and congestion at their works as to threaten continuity of operations at the rolling mills. They had at times had to carry stocks of nearly 50,000 tons of finished steel against a normal 20,000 tons. Despatch of their finished products to the ports was also affected by rail difficulties. As a large exporting company, they were greatly dependent upon the shipping situation. Until the volume of shipping available improved, their exporting activities were bound to be hampered to some extent by this factor.

The cumulative effect of these various factors had been to cause their output of rolled steel to fall below 1,000,000 tons for the first time since 1935, Lord Greenwood continued. Demands for steel were exceedingly heavy, with no likelihood of any diminution, and the circumstances called for increased production. Unless they could improve outputs it would not be possible to achieve the Government's policy of full employment and greater exports. To achieve these ends they would require the full co-operation of all concerned.

Additions during the year included expenditures on waste-heat boilers at steel plants; turbo-blowers at blast furnaces; additional land forming part of the site for new works; and expenditures at their collieries on American mining machinery and on clarification plants for improving the quality of coal for use at their own works. The expenditures at their pits were undertaken some time before the Government's proposals for nationalisation of the collieries.

Universal Beam Mill

Over a number of years the Board had considered the possibility of installing a modern mill for the rolling of universal beams or broad-flange sections. In July, 1944, they decided the time had come to formulate a concrete scheme. The company acquired 650 acres of land on the south bank of the River Tees, and on this a new steel plant and universal beam mill were to be constructed at a cost of about £8,000,000. The mill, which would have an annual capacity of 350,000 tons of universal beams, would be the most modern of its kind in the world. Under the most favourable conditions at least two years would be required to complete the construction of the steel plant and universal beam mill. In order to carry through the scheme expeditiously it would be necessary to secure a considerable amount of rolling-mill plant from the United States, and this was contingent upon the necessary dollars being made available. The scheme was awaiting Government approval and they were hopeful that it would be accorded a high priority in this connection.

Another important development, and one which had been put in hand, was the installation of a central ore unloading, ore-preparation and sintering plant at their Cleveland works, at a cost of over £1,000,000. The installation would enable the time required for discharging cargoes to be halved and would serve the whole of their blast furnaces. In addition to providing facilities for handling foreign ores, provision had also been made to deal with Cleveland ironstone from their own mines. The position in the Cleveland ironstone industry had markedly deteriorated since the war, due to loss of labour, absenteeism and the diminishing reserves of ironstone. It had been estimated that the working life of the Cleveland ironstone mines would be in the neighbourhood of 10 to 15 years. Output had been disappointing and the cost of winning the limited amount of stone available made the future of the mines uncertain.

Effects of Coal Nationalisation

The nationalisation of coal was a change which might seriously affect their undertaking as iron and steel manufacturers, said Lord Greenwood. The large reserves of coal which existed on their properties were most valuable as an assurance of adequate supplies for their iron and steel works, quite apart from their value as an ordinary commercial asset. The whole of their operations had been built up on the basis of regular supplies of coal and they had very adequate arrangements at the collieries for stocking coal so that, in the event of interruptions of production, they could still maintain deliveries to the works. One of the great problems under nationalisation would be to maintain the same arrangements as had been so satisfactory in the past. Almost equally important would be to ensure the supply of the right quality of coal, as variations in the sulphur and ash content of coal supplied to the coke ovens adversely affected operations at the blast furnaces and steel plants.

THE REPORT of the International Nickel Company of Canada for 1945 shows a net profit, after all charges, of $25,010,938, against $26,927,652 for the previous year, or $1.58 ($1.71) a common share. The charges include $12,461,941 for taxes ($19,170,349), or 85c. ($1.31) a common share. The president, Mr. Robert C. Stanley, says that curtailment of operations was begun in August and by the year-end the production of nickel was down to about 50 per cent. of the expanded capacity. In spite of the tremendous tonnage of ore removed during the war years, the proven reserves at the end of 1945 were 217,373,000 short tons, containing 6,866,000 tons of nickel/copper, against 212,368,000 and 6,806,000 at the end of 1938. Total sales of nickel in 1945 were 201,572,987 lb., a decline of 49,167,123 from 1944. Copper sales were 215,723,220 lb., or 48,988,705 lower.

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PIG-IRON AND STEEL PRODUCTION IN GREAT BRITAIN

The following particulars relating to pig-iron and steel production in Great Britain have been extracted from the Statistical Bulletin for February, 1946, issued by the British Iron and Steel Federation. Table I gives the production of pig-iron and blast-furnace alloys, with the number of furnaces in blast in January last; Table II, production of steel ingots and castings in January; and Table III, deliveries of alloy and non-alloy finished steel. Table IV summarises the activities of the steel industry as a whole during the six months ended January, 1946.

TABLE I.—*Production of Pig-iron and Blast-furnace Ferro-alloys.* (*Thousands of Tons.*)

District.	Furnaces in blast 2.2.46.	Weekly average production, January, 1946.					
		Hematite.	Basic.	Foundry.	Forge.	Ferro-Alloys.	Total.
Derby, Leics., Notts., Northants and Essex	22	—	15.2	16.2	1.3	—	32.7
Lancs. (excl. N.W. Coast), Denbigh, Flints, and Ches. / Yorkshire (incl. Sheffield, excl. N.E. Coast)	7	—	5.9	—	—	1.6	7.5
Lincolnshire	13	—	20.8	—	—	—	20.8
North-East Coast	25	5.5	25.5	0.7	—	1.3	33.0
Scotland	10	0.6	8.0	2.0	—	—	10.6
Staffs., Shrops., Worcs. and Warwick	9	—	6.1	1.0	—	—	7.1
S. Wales and Monmouth	7	2.6	15.9	—	—	—	18.5
North-West Coast	7	13.1	—	0.2	—	—	13.3
Total	100	21.8	97.4	20.1	1.3	2.9	143.5
December, 1945	99	21.0	99.3	20.3	1.4	3.5	145.5
January, 1945	101	19.4	87.9	16.8	0.7	2.3	127.1

TABLE III.—*Deliveries of Alloy and Non-alloy Finished Steel.* (*Thousands of Tons.*)

Product.	Weekly average.				
	1944	1945	1945		1946
			Jan.	Dec.†	Jan.
Heavy rails and sleepers	6.5	7.1	6.0	10.3	9.5
Heavy and medium plates	30.8	26.4	20.6	28.7	27.6
Plates—alloy	1.9	1.1	1.6	0.7	0.6
Other heavy steel products	38.2	33.1	31.2	29.0	28.2
Light rolled products (excl. wire rods and alloy steel bars)	46.2	41.9	41.9	39.8	43.1
Ferro-concrete bars	2.1	1.8	0.5	2.0	3.6
Cold rolled strip (excl. alloy)	4.2	4.0	3.7	3.4	3.8
Bright steel bars (excl. alloy)	4.9	3.9	4.2	3.2	3.8
Sheets, coated and uncoated (excl. alloy)	21.2	20.2	18.0	18.0	21 1
Tin, terne and blackplate	10.0	9·5	8.1	9.5	9.8
Tubes, pipes and fittings—alloy	12.9	11.2	9.3	11.8	12.0
Steel wire (excl. alloy)	12.2	10.2	9.7	9.2	11.4
Alloy bars, sheets, strip and wire	5.6	3.0	3.5	2.3	2.5
Steel tyres, wheels and axles	2.6	2.5	1.9	3.1	2.8
Steel forgings	10.9	7.5	9.1	5.8	6.0
Steel castings	6.8	5.0	5.6	3.2	3.3
Total production*	217.0	188.4	174.9	180.0	189.1
Less intra-industry conversion	24.5	17.8	18.2	15.9	15.9
Total deliveries	192.5	170.6	156.7	164.1	173.2
Deliveries of imported finished steel	5.0	1.0	1.5	0.1	0.2
Total deliveries of finished steel	197.5	171.6	158.2	164.2	173.4

* Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
† Revised.

(*Continued at foot of page 380*)

TABLE II.—*Production of Steel Ingots and Castings.* (*Thousands of Tons.*)

District.	Weekly average production, January, 1946.						
	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex	—	—	(Basic) 10.1	0.9	0.3	10.9	0.4	11.3
Lancs., (excl. N.W. Coast) Denbigh, Flints., and Ches. / Yorkshire (excl. Sheffield and N.E. Coast)	1.0	17.4	—	1.4	0.5	19.5	0.8	20.3
Lincolnshire	—	22.7	—	—	0.1	22.7	0.1	22.8
North-East Coast	2.6	40.3	—	0.4	0.5	42.7	1.1	43.8
Scotland	3.3	23.5	—	0.3	0.6	26.7	1.0	27.7
Staffs., Shrops., Worcs. and Warwick	—	12.4	—	0.4	0.6	12.5	0.9	13.4
S. Wales and Monmouth	4.3	40.1	(Basic) 4.9	0.6	0.1	49.6	0.4	50.0
Sheffield	7.9	18.8	—	5.0	0.6	30.9	1.4	32.3
North-West Coast	0.1	3.3	(Acid) 3.8	—	—	7.2	—	7.2
Total	19.2	178.5	18.8	9.0	3.3	222.7	6.1	228.8
December, 1945	21.8	170.9	18.4	7.9	2.7	215.9	5.8	221.7
January, 1945	19.7	164.5	15.6	11.1	5.4	205.8	10.5	216.3

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PERSONAL

MR. FREDERICK FRANKS has resigned his directorship of Ernest Hinchliffe, Limited, fluorspar producers, etc., of Sheffield.

MR. R. S. BENNETT has been appointed chief engineer of Thos. Firth & John Brown, Limited, following the resignation of Mr. E. D. Bool.

MR. WALTER J. COOPER, late of A. C. Cossor, Limited, has been appointed purchase manager to the Harland Engineering Company, Limited, of Alloa, Scotland.

MR. GILBERT FENN, who has been in the service of the Lilleshall Company, Limited, pig-iron makers, etc., of Shifnal, Salop, for 66 years, has retired at the age of 79.

MR. H. S. ROBINS, lately general manager, has been appointed joint managing director of Francis Morton & Company, Limited, constructional engineers, of Garston, Liverpool.

SIR PATRICK ASHLEY COOPER, who is a director of the General Electric Company, Limited, and other companies, has been appointed Sheriff for the county of Hertfordshire.

MR. F. WORTON and MR. W. DENTON have been appointed works managers of Brown, Bayley's Steel Works, Limited, Sheffield. MR. H. BULL continues in the position of works director.

MR. W. W. COUTTS has been appointed executive vice-president (managing director) of the American Gray Iron Founders' Society. He succeeds Mr. W. W. Rose, who has retired because of ill-health.

MR. ROBERT CRAIG, Glasgow manager, has been presented with a wallet of notes from the directors of Shanks & Company, Limited, ironfounders and sanitary engineers, of Barrhead, on completing 50 years' service with the firm.

SIR ERNEST ROBERT CANNING, joint managing director of W. Canning & Company, Limited, of Birmingham, is the newly-appointed Sheriff for the county of Warwickshire. Sir Robert was Lord Mayor of Birmingham, 1937-38, and is a governor of Birmingham University.

MR. A. E. MCRAE SMITH is relinquishing his position with the development and research department of the Mond Nickel Company, Limited, to take charge of the foundry consulting activities of Keighley Laboratories, Limited, consulting metallurgists and foundry specialists, as from May 1.

MR. GEORGE CLARK, J.P., chairman of the Bryan Donkin Company, Limited, mechanical and gasworks plant engineers, etc., of Chesterfield, is to receive the honorary Freedom of the Borough of Chesterfield, of which council he was a member for 35 years until his retirement last November. Mr. Clark recently completed 53 years' service with the Bryan Donkin Company, Limited.

MR. ROBERT SHONE has been appointed secretary of the British Iron and Steel Federation. He will combine this appointment with the directorship of the economic work of the Federation. During the war Mr. Shone was General Director of Statistics, Costs and Prices of the Iron and Steel Control. He has had a distinguished academic career. After taking an honours degree in engineering, followed by research work in metallurgy, he held a Commonwealth Fellowship in America, where he did post-graduate work in economics. For several years Mr. Shone worked on the commercial side of the steel industry. He was for a time a lecturer at the London School of Economics, and in 1936 took charge of the statistical and economic work of the Federation. He is 39.

Wills

CRADDOCK, T. H., of Folkestone, retired iron merchant	£25,650
SOWDEN, HENRY, of Rotherham, a director of the Rother Boiler Company, Limited	£5,210

B.E.T.R.O.

The British Export Trade Research Organisation has appointed Mr. C. K. Squires to take charge of Scandinavian matters. He will have his headquarters in Stockholm. Mr. P. Thornton is to open an office in Cairo, from which he will take care of potential business generally emanating from the Middle East. The organisation has acquired a headquarters office at 48, Dover Street, London, W.1, where Mr. S. L. Lewis is the executive who services existing and prospective members.

PIG-IRON AND STEEL PRODUCTION IN GREAT BRITAIN (*Continued from page 378*).

TABLE IV.—*General Summary of the Pig-iron and Steel Industry.* (*Weekly Average in Thousands of Tons.*)

Period.	Iron ore output.	Imported ore consumed.	Output of pig-iron and ferro-alloys.	Scrap used.	Output of steel ingots and castings.	Deliveries of finished steel.	Steel stocks* held by producers, etc.
1944	297.6	46.8	129.5	141.7	233.5	197.5	2,171.0
1945	272.5	77.2	136.7	138.5	227.3	171.6	1,683.9
1945—August	221.3	77.9	125.2	110.6	185.9	142.3	1,280.8
September	246.1	97.8	139.5	145.1	240.6	176.9	1,263.8
October	247.4	106.3	146.1	146.1	243.0	166.5	1,211.5
November	249.0	104.4	150.0	147.3	246.9	179.4	1,212.5
December	231.4	100.4	145.5	132.3	221.5†	164.2†	1,189.7†
1946—January	245.3	96.7	143.5	134.5	228.8	173.4	1,224.1

* Stocks at the beginning of the years and months shown.
† Revised.

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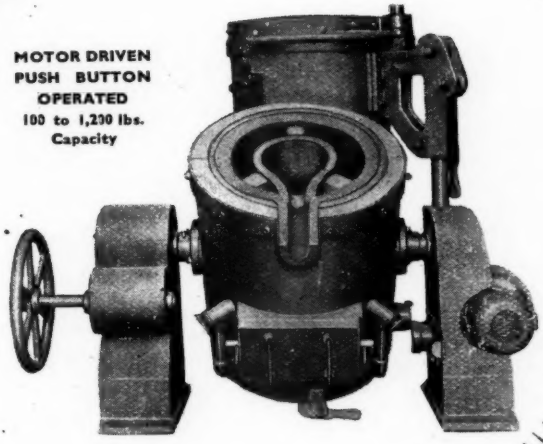

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NEWS IN BRIEF

THE PRESSED STEEL COMPANY, LIMITED, of Oxford, are planning to produce 100,000 domestic refrigerators a year, and for this purpose a continuous vitreous enamelling plant is being installed.

LANARKSHIRE STEEL INDUSTRY must be retained, the coal industry must be brought to a gradual end, and some ancillary heavy industry such as electrical engineering must be attracted if the county was to be stable and prosperous, declared Mr. Tom Fraser, Undersecretary of State for Scotland, at Blantyre on March 25.

IN RESPONSE TO THE Government's appeal for higher production, over 200 executives of the 28 subsidiary companies of the Tube Investments, Limited, group met at Birmingham on March 21 to consider new plans for stepping-up output proposed in an address by Mr. I. A. R. Stedeford, chairman and managing director of Tube Investments, Limited.

IN CONJUNCTION WITH Mr. Ellis Flower, a director of Eagle Core Oils, Limited, Rochdale, Mr. J. F. Gist, managing director of Preston & Bishop, Limited, engineers, founders, etc., of Clement Street, Birmingham, has formed a patternmaking company known as Lancashire Pattern Makers, the address of which is Providence Works, St. Helens Junction.

IT WAS ANNOUNCED in Manchester last week that the National Union of Foundry Workers, the United Metal Founders' Association and the Ironfounding Workers' Association are to merge. Their total membership will amount to almost 55,000. The new union, to be known as the Amalgamated Union of Foundry Workers, will come into being on July 1.

MR. C. MOODY, assistant works manager, at the Acklam Works, Middlesbrough, of Dorman, Long & Company, Limited, in an address to the Cleveland Institution of Engineers, foreshadowed the ultimate extinction of the steam locomotive in steelworks. He thought that more material would be moved on conveyors and belts and the steam locomotive will be superseded by the fuelless locomotive, as it has been in Germany.

BABCOCK & WILCOX, LIMITED, who some years ago acquired the business of Dewrance & Company, Limited, announce that they have now transferred the whole of the Babcock valve business and the manufacturing capacity of their Dumbarton valve works to that company. Dewrance & Company will continue to operate as a separate organisation and will maintain the manufacture, supply and service of certain designs of Babcock valves.

MEMBERS OF THE Institute of British Foundrymen are invited to attend a meeting of the Royal Society of Arts to be held on Wednesday next at 1.45 p.m. at John Adam Street, Adelphi, London, W.C.2, when Mr. J. G. Pearce, Director of the British Cast Iron Research Association, will read a Paper on "Cast Iron in Contemporary Building and Engineering." Tickets of admittance are obtainable either from the Institute at St. John Street Chambers, Deansgate, Manchester, 3, or from the Royal Society of Arts.

RAW MATERIALS DEPARTMENT

The transfer of the Raw Materials Department from the Ministry of Supply to the Board of Trade, announced some time ago, took effect on April 1. The address of the Department is I.C.I. House, Millbank, London, S.W.1. Branches of the Department situated outside Shell Mex House remain at their present addresses, but under the Board of Trade.

The following materials, hitherto dealt with by the Raw Materials Department, will, however, remain with the Ministry of Supply:—Agates, antimony, arsenic metal, cadmium, carbon and graphite electrodes for furnaces, chrome, cobalt, copper, columbite, diamond dies and tools, dolomite, fluorspar, lead, quartz crystals, tantalite, tin, foundry bonding materials (including dextrine), grinding wheels (including abrasives), iron and steel and ferro-alloys, magnesite, molybdenum, monazite sand, nickel, refractories, tungsten, vanadium, zinc.

Joint Orders giving effect to the transfer and scheduling of the Control Orders involved have been issued by the Ministry of Supply and the Board of Trade. The Orders are entitled "The Ministry of Supply and Board of Trade (Various Controls) (Nos. 1 and 2) Orders." It is provided that any relevant licences issued prior to April 1 will remain in force.

By an Order in Council, which also became effective on April 1, the Board of Trade has taken over the trading functions of the Ministry of Supply in respect of any transferred materials, together with any relevant contracts entered into by the Raw Materials Department on behalf of the Ministry, and the ownership of the stocks held by the Department passes to the Board.

IRONFOUNDRY INDUSTRY WITHDRAWN FROM E.W.O.

The extent of the withdrawal of the iron and steel industry from the scope of the Essential Work Orders, on May 15 next, has been widened to cover the following additional sections of the industry:—Ironfounding, iron and steel tubes, pipes and fittings, and the steel sheets and tinplate section. This means that the whole of the iron and steel industry will be withdrawn from the scope of the Essential Work Orders on May 15.

Notices will be issued to the individual undertakings which are to be de-scheduled, giving them at least one month's notice. Until individual de-scheduling takes effect, the provisions of the Essential Work Orders remain in force for all employers and workers in scheduled undertakings.

A.F.A. JUBILEE CONGRESS

The article which we published last week under this heading was the official release to the Press from the American Foundrymen's Association, but was inaccurate in several statements. Mr. Gardom, because of the illness of Mrs. Gardom, is unable to participate. The pre-Convention tour has been abandoned and replaced by a post-Convention works visit. The inclusion of the name of Mr. Makemson is a little premature, as the matter is not yet finalised. A statement from British sources is expected shortly.

TO SLAG PENETRATION

SLAG penetration of refractory materials normally accompanied by erosion, surface spalling, shrinkage, etc., is frequently responsible for the ultimate failure of refractories. To reduce the destructive effect of slag penetration, volume-stable, dense, low-porosity, low-permeability bricks, with the correct chemical composition, must be used. A characteristic of G.R. products is that they possess these necessary qualities and thus ensure minimum slag penetration. The services of G.R. engineers are available on request, to users, on the choice and application of refractories.

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Raw Material Markets

IRON AND STEEL

Production of pig-iron, both basic and foundry, is being stepped up to the utmost. The light-castings industry is very active, with the prospect of full employment for a long time to come. There is increasing pressure on the furnaces by the general engineering, speciality and jobbing foundries, which are now getting back into normal work and specifying considerable tonnages of low- and medium-phosphorus pig-iron, hematite and refined iron. Up to now the furnaces have had no difficulty in meeting requirements; in fact, makers of refined pigs have been agitating for some time for permission to send supplies abroad and recently this was granted up to a limited capacity and for specific destinations.

Large quantities of cast-iron and steel scrap are needed for the foundry trade. Supplies are not too good at the moment and there are complaints in several districts of the lack of suitable scrap. Foundries are experiencing no trouble in getting limestone, ganister and firebricks, but supplies of cupola coke are only just about sufficient to cover current requirements.

There is an urgent demand for semi-finished steel from the re-rollers. Stocks of billets have been dwindling for some time, as supplies from English and Welsh steelmakers and from abroad have not kept pace with consumption and it is to be hoped that arrangements can be made for much larger imports. Producers of sheet bars appear to be meeting the demand from sheet makers. These mills are particularly active and it is difficult to get offers of new business for sheets except for delivery in the third or fourth quarter. Rollers of small steel bars, special sections, strip, etc., are also busy on both home and export account, and large quantities of billets are essential if maximum outputs are to be maintained. Plate mills are particularly busy, and it is difficult for home consumers to get reasonable delivery dates offered. Some mills are completely off the market until further notice.

NON-FERROUS METALS

The Ministry of Supply has announced that on and from April 1 the price of tin sold by the Directorate of Non-Ferrous Metals for export from the United Kingdom will be £357 per ton, f.o.b. U.K. port, for common tin in ingots (of 99 per cent. minimum purity, but less than 99.75 per cent. tin content), in lots of 1 ton and upwards, with the usual extras for all other grades, shapes and sizes. This follows the rejection by the Nigerian Chamber of Mines, representing producers, of a Government offer for a renewed contract at a price of £300 per ton, f.a.s. Nigerian ports. The old agreement between the Ministry and Nigerian producers for the bulk purchase of Nigerian tin expired at the end of last year. While there is certainly no tin to spare, there is sufficient metal available to meet requirements approved by the authorities.

Demand for zinc in the United States, though rather quiet at the present time, is expected to improve shortly under the influence of the more active conditions in the steel industry. Zinc deliveries of late have fallen somewhat behind schedule, due to producers' difficulties of obtaining an adequate flow of box cars, which have been held up through strikes.

Supplies of lead continue to be rationed in this country. Deliveries are being maintained fairly equitably, but users are not by any means getting all the metal that they require.

OBITUARY

MR. WILLIAM RICHARD HAMMOND, who died on March 20 following a prolonged illness, was the founder of the Hammond Engineering Company, Limited, of Enfield. He was 56.

MR. J. H. SMETHURST, senior partner of James Smethurst & Son, engineers, iron and brass founders, etc., of Foundry Street, Warrington, has died at the age of 79. In 1937 he was given the freedom of the Borough of Warrington.

M. EMILE TONNEAU, formerly head of the blast furnaces and steelworks of the Société Anonyme John Cockerill, Seraing, Belgium, died recently, aged 86, at Jemeppe-sur-Meuse, Belgium. He was well known as an authority on technical matters connected with the steel industry.

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Stockport, April 10—1,536 yds. of 12-in., 1,902 yds. of 10-in., and 1,104 yds. of 8-in. cast-iron piping and irregulars, for the Town Council. Mr. H. Russell, secretary, Gas Department, Stockport.

Willenhall, April 16—Cast-iron manhole covers and gully grates during the 12 months ending March 31, 1947, for the Urban District Council. The Engineer and Surveyor, Council Offices, Willenhall.

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